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Strength Chracteristics of Self-Compacting Concrete Partially Replaced With Waste Marble Powder

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Abstract

Self−compacting concrete is one of the most revolutionary developments in concrete research; this concrete is able to flow and to fill the most congested places of the form work without vibration. This research work presents properties of self-compacting concrete after replacement of fine aggregate with powder of waste marble at different percentages (0%, 10%, 20%, 30% 40% and 50%). In this study, the waste marble powder, finer than 4.75 mm is used for the replacement of fine-aggregate. And with the increment in the dose of waste marble powder, the workability of SCC is increased. For the dose of waste marble powder replacement 30%, the fresh properties observed were good in comparison of dose 0%, 10%, 20%, 40% and 50% of waste marble powder replacement. The compressive strength test is conducted at different mix proportion of SCC with waste marble powder and the highest compressive strength has been found at 30% powder of waste marble replacement as compared to other mixes at 7 and 28 days ages.

Keywords: *Self−compacting concrete; Waste marble powder; Workability; etc.*

1. INTRODUCTION

In the ability of self-compacting concrete involves not only high deformability mix, but also resistance to segregation between coarse aggregate and mortar when the concrete flows through the confined zone of reinforcing bars (Arivalagan S, 2013). Self-compacting concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its self weight completely filling formwork and has a ability of achieving full compaction (Gaywala N. R. and Raijiwala D. B, 2011). Self-compacting concrete is one of the most revolutionary developments in the research of concrete field, this concrete is able to flow and to fill the most restacted places of the form work without vibration (ZoranGrdic*et al.* 2008). Self-compacting concrete (SCC) is a new category of high performance concrete charactererized by its ability to spread into a heavily reinforced area under its self weight without the need of vibration and has excellent deformability and high resistance to segregation. There are numerous advantages of using SCC as- (i) Fast placement of concrete. (ii) Better consolidation around reinforcement.(iii) Easily placed in thin walled elements with limited access. (iv) It improves the quality, durability and reliability of concrete structures. (v) Ease of placement results in cost saving through reduction in equipments and requirement of labor (Aggarwal Paratibha *et al.* 2005). Self compacting concrete (SCC) is an innovative development in the field of conventional concrete, which requires high binder content to increase its segregation resistance (Mahajan Sumit and Singh Dilraj, 2013). Self compacting concrete (SCC) can be defined as a fresh concrete which possesses superior flowability under maintained stability. SCC was first developed in Japan in 1988 in order to achieve durable concrete structures by improving quality in the construction process (Goodier C I, 2003). Self compacting concrete (SCC) is a type of concrete that has the capacity of consolidation under its self weight (Pai B.H.V. *et al.* 2014).

2. MATERIALS & METHODS

Cement: Ordinary Portland Cement (OPC) of 43 grade and Shree brand conforming to IS- 8112-1989 was used throughout this research. The Normal consistency of this cement was 28%. Physical properties of used cement are given in table-1.

Fine aggregate: Locally available, sand of river Ramganga conforming to IS: 383-1970, Zone-II was used throughout this research. Specific gravity, Bulk density and Fineness modulus of used sand were 2.6, 1774 kg/m^3 and 3.18 respectively.

Coarse aggregate: Locally available crushed stone aggregates conforming to IS: 383-1970, of 10 mm maximum size was used as coarse aggregate throughout

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this research. Specific gravity, bulk density and Fineness modulus of used coarse aggregate were 2.7, 1483 kg/m^{3}and 6.45 respectively.

Waste marble powder: Waste marble powder was collected from the locally available manufacturing unit in Moradabad (U.P.). It was initially in wet form (in slurry form), but it is used in dry form by exposing it in the sun light and after that it is finally sieves by IS 4.75 mm sieve before mixing (Fig-1). Physical properties of waste marble powder are given in table-2.

Water: Potable water for mixing and curing of concrete specimens was used throughout the research.

Superplasticizer: Sika viscocrete 20-HE was used in this research. It is a revolutionary high range water content reducer based on polycarboxylate ether (PCE). It has been developed for the production of concrete of high early strength and magnificent workability requirements.

SCC MIX DESIGN: Okamura method (Rational mix design method) was used for mix design of self compacting concrete.Okamura and Ozawa (1995) was proposed a simple mix proportioning system assuming general supply from ready mixed concrete plants. The coarse and fine aggregate contents were fixed so that self compactibility can be achieved easily by adjusting the water powder ratio and super-plasticizer dosage only. The coarse aggregate content in concrete was fixed at 50 % of the solid volume. The fine aggregate content was fixed at 40%of the mortar volume. The water power ratio in volume was assumed at 0.9 to 1.0 depending on the properties of the power. The dosage of super-plasticizer and the final water-power ratio were determined so as to ensure self compactibility.

In the present study, M-30 grade of SCC was used for all experimental work. All the test of Self-compacting concrete (SCC) in hardened state, performed in present study.

Table 1. Physical properties of cement

S. No.	Characteristic	Experimental values	Codal Requirement (IS: 8112-1989, OPC 43 grade specifications)
a	Fineness of cement(% retained on IS 90 micron sieve)	4.83%	10%
b	Soundness of cement(By Le-Chatelier method)	0.9 mm	Not more than 10 mm
c	Initial setting time	65 min	Not less than 30 min
d	Final setting time	224 min	Not more than 600 min
e	Compressive strength (7 days)	23.5 N/mm^2	16.0 N/mm^2
f	Compressive strength (14 days)	34.8 N/mm^2	22 N/mm^2
g	Compressive strength (28 days)	45.0 N/mm^2	43 N/mm^2

Table 2. Physical properties of waste marble powder

S. No.	Characteristic	Result
a	Colour	White
b	Form	Powder
c	Odour	Odourless
d	Specific gravity	2.68

3. RESULTS & DISCUSSION

In this study, hardened properties of self-compacting concrete were investigated by using waste material (powder of waste marble) at six replacement rates for the fine aggregate. compressive strength test were carried out to determine mechanical properties of hardened concrete at 7 and 28 days age.

Mix proportions of SCC with powder of waste marble

We have cast 30 cubes of SCC with or without powder of waste marble at different percentages for the age of 7 days. Five cubes from each mix such as cube of SCC with 0%, 10%, 20%, 30%, 40% and 50% powder of waste marble. Each cube was tested for 7 days compressive strength. 30 cubes were also casted for 28 days of same percentages of powder of waste marble. These mix proportions were given in table 3.

Table 3. mix proportions of SCC with waste marble powder

S. No.	% of fine aggregate	% of waste marble powder	No. of cube for 7 days compressive strength	No. of cube for 7 days compressive strength
1	100%	0%	5	5
2	90%	10%	5	5
3	80%	20%	5	5
4	70%	30%	5	5
5	60%	40%	5	5
6	50%	50%	5	5
Total			30	30

Comparison of compressive strength at 7 days between all the samples of SCC with waste marble powder-

We have compared all the samples of SCC with waste marble powder at different proportions and we found that there was an increase in compressive strength with the increase in percent of waste marble powder till 30% after that there was decrease in compressive strength at 40% and 50% which given in table 4.

The graphical representations of average compressive strength of SCC with waste marble powder as given in Figure 1.

Table 4. Comparison of compressive strength at 7 days between all the samples of SCC with waste marble powder

Sample no.	Percentage of waste marble powder in SCC	Average value of compressive strength at 7 days of 5 samples of cubes in MPa
1	0%	17.465
2	10%	17.798
3	20%	18.117
4	30%	18.269
5	40%	15.560
6	50%	15.001

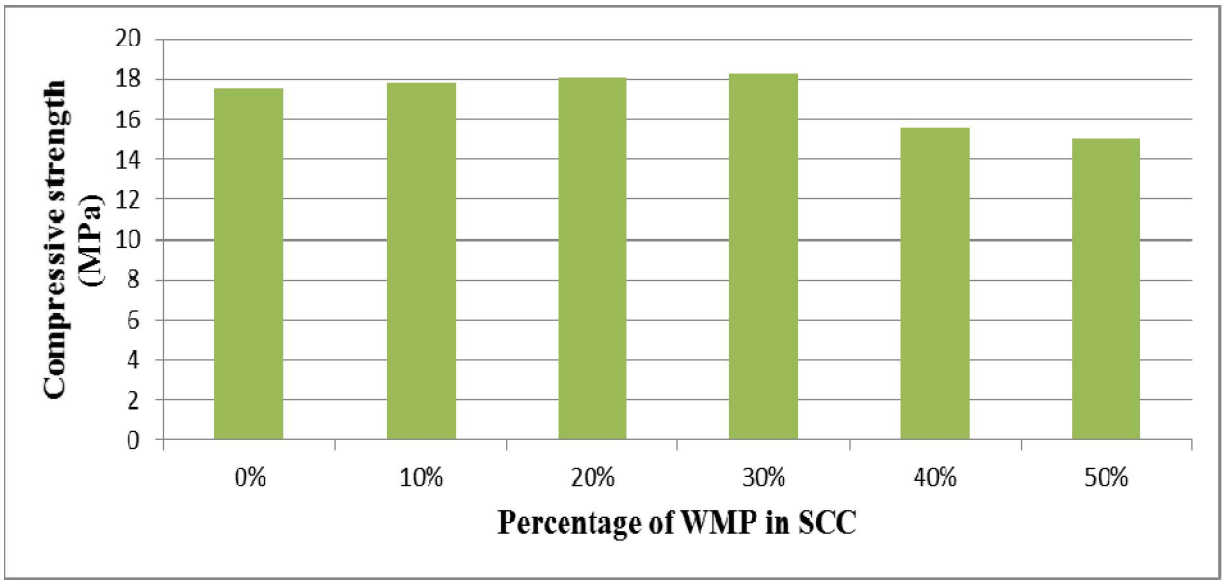

Fig. 1: Comparison of compressive strength at 7 days between all the samples of SCC with waste marble powder

Comparison of compressive strength at 28 days between all the samples of SCC with waste marble powder

We have compared all the samples of SCC with waste marble powder at different proportions and we found that there was an increase in compressive strength with the increase in per cent of powder of waste marble till 30% after that there was decrease in compressive strength at 40% and 50% which given as:

The graphical representations of Comparison of compressive strength at 28 days between all the samples of SCC with waste marble powder are given in Figure 2:

Table 5. Comparison of compressive strength at 28 days between all the samples SCC with waste marble powder

Sample no.	Percentage of waste marble powder in SCC	Average value of compressive strength at 28 days of 5 samples of cubes in MPa
1	0%	31.230
2	10%	32.68
3	20%	33.159
4	30%	33.703
5	40%	32.977
6	50%	30.32

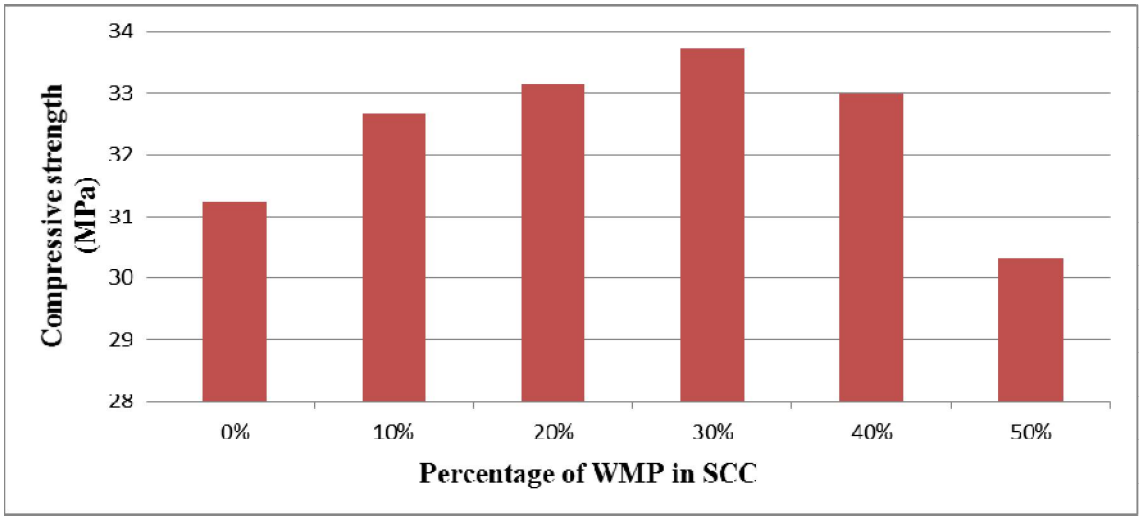

Fig. 2: Comparison of compressive strength at 28 days between all the samples of SCC with waste marble powder

4. CONCLUSION

From the present study, following conclusions may be drawn:

1. The results of compressive strength (hardened properties) have shown significant performance difference and the higher compressive strength has been obtained for waste marble powder replacement. The highest compressive strength has been found at 30% waste marble powder replacement as compared to other mixes at 7 days ages.
2. The highest compressive strength has been also found at 30% powder of waste marble replacement as compared to other mixes at ages of 28 days.

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